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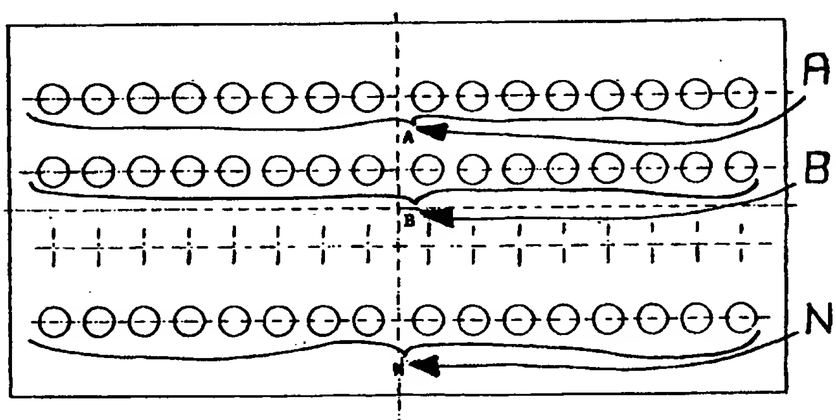

(57) Abstract

Single-stage method for the production of resin preforms, comprising the phases of: filling a plurality of multiple-cavity moulds, holding and cooling down said resin inside said moulds, removing the moulded preforms from said moulds, subjecting said preforms to a subsequent temperature conditioning phase, transferring said preforms to appropriate blow-moulding tools and clamping them therein for the final blow moulding operation, and wherein each one of said multiple-cavity moulds comprises a plurality of cavities defined in several (n) distinct clusters belonging to the same mould, said cavities being cooled down by means of a forced circulation of cooling medium through appropriate cooling conduits, wherein the cavities belonging to a same cluster are cooled in a distinct and differentiated manner with respect to the cavities belonging to the other clusters of cavities provided in the same mould. Said clusters of preforms are subjected individually to said temperature conditioning phase in an orderly sequence, so as to cause said clusters of preforms to queue up for reaching said temperature conditioning phase after a differentiated time.

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HIGH-PRODUCTIVITY SINGLE-STAGE METHOD AND APPARATUS FOR PRODUCING CONTAINERS MADE OF THERMOPLASTIC MATERIAL

DESCRIPTION

The present invention refers to an improved method and apparatus for the large-scale production of containers made of a thermoplastic material, such as in particular polyethylene terephtalate (PET) and polypropylene (PP), intended for applications involving their being filled with liquids that may be also at quite elevated temperature and/or contain CO_2 (carbon dioxide) gas.

In the field of technologies and machines for producing containers of the above cited kind there are a number of developments and improvements aimed at obtaining, on the one side, increasingly robust and improved containers, capable of being used for both hot-filled liquids and carbonated beverages, and, on the other side, production processes and related apparatuses that are capable of manufacturing said containers in an increasingly reliable, cost-effective, versatile manner to increasingly high quality standards in a highly competitive industrial context of very large-scale production.

Such production processes are generally known to be able to be schematically divided into two basic typologies, ie. single-stage and two-stage processes.

The features and characteristics that are typical of said processes, and differentiate them from each other in terms of both equipment and operation , are

largely known to all those skilled in the art, so that no need arises here to dwell on them any longer.

Inherent to any single-stage process there is the fact that an uneven heat distribution is unfailingly brought about in the cross-sectional direction of the wall thickness of the preform when the latter is removed from the related cavity in the mould into which the molten resin had been injected.

Various processes have been actually patented, which cover time and temperature parameters of the preform when this is removed from the injection mould, in view of optimizing the related cycle times.

All patent literature covering single-stage processes discloses almost invariably a final forming or moulding stage of the container of thermoplastic material which is in some way or other carried through a conditioning station to reach an even wall temperature throughout the cross-section of the same wall, said temperature corresponding to the preferred molecular orientation temperature of the thermoplastic resin involved.

A currently most preferred technique involves the use of a process of continuous extrusion of a flow of molten resin so as to sequentially fill a plurality of moulds, such as this is described in following patent specifications:

- GB 767,164
- FR 2.089.154
- FR 2.114.455
- US 4,242,073.

Furthermore, owing to the difference existing between the time requirements for the injection moulding/cool-down phase and the blow moulding phase, which usually requires a time that may be even four times shorter than the one involved in the previous phase, the practice is also largely known which consists in using, in a single-stage apparatus, a number of blow-moulding moulds which is a whole multiple of the number of corresponding injection-moulding moulds, so as to

compensate in this way for the difference existing in the time requirements of the two phases. These phases, in fact, are unavoidably organized in series, with a greater number of injection-moulding moulds in such a manner as to produce preforms in such quantities and at such a rate as to fully saturate the utilization of the blow-moulding moulds.

The patent specifications US 4,261,949 and 4,313,720, both to Emhart Industries Inc., are totally self-explaining and descriptive in this connection.

The above cited teachings, ie. the continuous extrusion in a plurality of multiple moulds, associated to a combination of blowing moulds which are in a number that is a multiple of the number of the corresponding injection moulds, have been brought together, and generally improved and illustrated, in the US patent no. 4,372,910 and its divisional no. 4,470,796 to Stroup, while a preferred embodiment thereof has been implemented in a single-stage injection-blow moulding apparatus of Van Dorn Plastic Machinery generally disclosed in said US patent to Stroup.

Said US patent no. 4,372,910 (along with its divisional) essentially describes and claims a process and apparatus for the production of hollow plastic products, typically bottles.

As compared with the prior-art, the therein disclosed invention covers a single-stage extrusion process for producing preforms that are successively stretched and blown into the final or finished product. Said extrusion process includes the possibility of carrying out a continuous extrusion, wherein the molten material is fed in sequence into a plurality of preform-moulding moulds. The process is organized in such a manner that, when the extruded melt is being fed into a mould, eg. the first one of a set of moulds, the other moulds are closed by appropriate valves actuated in a sequence. Once said first mould has been filled, the same is closed, while a second mould is opened to be in turn filled by the flow of extruded melt. This sequence goes on until all of the moulds in the set have been filled, after which the process is starts again from the first mould that has in the meantime transferred its preforms to the respective blow-moulding station.

The sequence in which the valves are actuated is such as to ensure that the molten material is absorbed, ie. taken up almost constantly, so that the extrusion process takes place continuously, ie. without interruptions, with clear operational and practical advantages.

Ome of the most significant advantages claimed in the above cited patent lies in the fact that, considering that the preform moulding operation takes a considerably longer time, which quite often is a multiple of the time required by the subsequent blow-moulding operation, it is not necessary to wait, at the end of a blow-moulding operation, for a subsequent preform moulding operation to reach its conclusion (which thing would lead to a fully inadequate efficiency level of the blow moulding station), since through a multiplication in parallel and a process for cyclically feeding a plurality of preform moulding moulds, which in turn are adapted to feed a plurality of blow-moulding stations, a better utilization of the whole production plant is allegedly obtained.

Another advantage is claimed to lie in the fact that the continuous extrusion process contributes to a further improvement in the utilization of the plant, so that the combination of the various elements described in the above cited patent would conclusively lead to a drastic improvement in the overall production efficiency.

However, the invention disclosed in the above cited patent has in practice a number of drawbacks that tend to limit the extent of the claimed advantages: some of such drawbacks are described in the Italian patent no. 1 265 567, filed by the Applicant, to which reference is therefore made here for the sake of brevity. Anyway, they essentially relate to the problems that are typically brought about to the resin filling and compression operations performed by the same resin extruder, as well as the therewith associated problems brought about by the resin undergoing shear stress, ie. frictioning, and hence generating acetaldehyde.

Further drawbacks, which generally come afloat in plants with a high output capacity, derive from the fact that an increase in the number of cavities in each mould, an increase in the number of the same moulds, and therefore an increase in

the total volume and, hence, in the cost of the moulds, along with an increase in the cost of the control apparatuses that have to be associated therewith, when added to an increase in the length anf the diameter of the extruder and, as a result, in the related costs and production and logistic complexity, lead to overall charges that are no more sustainable, even in front of an altogether moderate increase in output capacity.

Furthermore, the greater total number of mould cavities provided in such plants require a correspondingly high flow of molten resin to be processed by the extruder and this of course requires the use of an extruder with a correspondingly large diameter. It has however repeatedly been found that, in such a kind of extruders, the film of resin that tends to spread out on the inner walls of the extrusion barrel, and fails to be directly pushed forward by the screw, actually picks up a no more negligeable thickness and, owing to the type of path to be covered when moving towards the cavities, it tends to particularly concentrate in some cavities, while neglecting other ones.

Considering now that such a resin moves forward at a slower rate and is in direct contact with the heating walls, it ensues that it is heated up with a greater intensity due to the combined effect of the longer dwelling time in the extruder and said contact with the heating wall; such a greater and sensible overheating effect tends to generate a considerable amount of acetaldehyde that concentrates, along with said fraction of resin, just in said determined cavities.

In conclusion, preforms are in this way produced in which there is a concrete risk of releasing acetaldehyde in amounts that are clearly beyond the allowable limits set by the applying regulations.

From the disclosure in the European patent EP 0 071 258 to Valyi, the teaching is also known according to which the preform is allowed to rapidly cool down in the injection mould until its temperature sinks below the point to which the highest crystallization rate for the given plastic material corresponds. The same preform is then quickly removed from the injection mould while it still has an uneven

distribution of its temperature, and transferred to a holding station provided between the injection mould and the conditioning station so as to allow the heat content of the preform to keep changing until an average temperature suitable for the orientation is reached, thereby setting the injection mould free for the next preform moulding operation and, therefore, reaching a shorter cycle time while preserving the basic properties of the bottle to be produced.

Such a teaching, however, involves the addition of a supplementary holding station, ie. mould, with all associated drawbacks of an economic nature that thsi implies and all related production complications deriving from the construction of such a mould along with the therewith associated insertion, removal, ejection, driving and control means.

Based on the above considerations, it therefore is a main purpose of the present invention to provide a single-stage process and apparatus for the production on an industrial scale of a container of thermoplastic resin which is thermally stable, capable of being filled with both hot and carbonated liquids wherein a higher output is ensured with a smaller number of moulds, while doing away with the afore described economic and technical drawbacks.

Such an apparatus shall furthermore be fully reliable and easily implemented with the use of known, readily available techniques.

Such main aim of the present invention, along with further features of the present invention, is reached in a method to mould bottles of thermoplastic material through the use of a sensibly reduced number of preform moulding moulds in which the number of cavities are increased and the preforms produced in such cavities are removed therefrom in clusters that are conveyed to an appropriate blow-moulding station in an orderly sequence and, therefore, according to a definite holding or waiting procedure.

In order to prevent the preforms from cooling down in a differentiated manner, and therefore in a manner that is not appropriate in view of a correct blow

moulding process, during said holding period, the various preform clusters are cooled down, when still in the related mould cavities, in a intentionally differentiated manner aimed at ensuring that all preforms, when inserted in the blow-moulding dies, exhibit the same, optimal temperature

These and further aims and advantages of the present invention will anyhow be more readily and clearly understood by those skilled in the art from the description that is given below. The invention itself may be implemented by definite parts and/or arrangements thereof, a preferred embodiment of which is described and illustrated below by way of non-limiting example with reference to the accompanying drawings, in which:

- Figure 1 is a basic, schematical view of a mould of an apparatus according to the present invention;

- Figure 2 is a view of a possible configuration of the preforms removed from the mould shown in Figure 1;

- Figure 3 is a basic, schematical view of an apparatus according to the present invention;

- Figure 4 is a view of an improved variant of the apparatus shown in Figure 3;

- Figure 5 is a view of a configuration of the means for detecting the temperature of the preforms before conditioning;

- Figure 6 is a view of a symbolic diagram showing the temperature pattern of distinct preform clusters after they have been removal removed at the same time from the same mould, said preforms having previously been heated up in a differentiated manner.

When reference is made to the accompanying drawings, which are only used to illustrate some preferred embodiments of the present invention and shall

therefore not be intended as limiting the scope thereof, it can be noticed that the basic peculiarity of the present invention lies essentially in the combination of two distinct measures, the first one of which consists in providing the injection mould 1, in which the preforms are moulded, with a plurality of cavities 2 that must be grouped into a number n of clusters, or sub-groups, namely the clusters of cavities belonging to and identified by the same line A, B ...N containing preferably an identical number of cavities, as this is shown symbolically in Figure 1.

So far there would actually be nothing really new with respect to the prior art, since all cavities contained in a single mould can be divided into clusters or sub-groups, eg. in a number of n, wherein each cluster is arranged to contain a smaller number of cavities, without on the other hand bringing about, by this mere fact, any actual invention and/or advantage of any kind.

Such a measure is advantageously and innovatorily completed by implementing a cool-down system, along with all related means and devices, inside the mould in such a manner as to enable it to cool down each one of said n clusters of cavities in a differentiated manner, as appropriately selected according to the needs, during the phase in which the molten resin cools down and solidifies in the mould cavities, in such a manner that, when the preforms are removed from their respective cavities of the respective mould, they exhibit a different temperature, as this is clearly induced by the dissi.ilarity in thecool-down temperature of each respective cavity, said temperature being of course the same for all preforms belonging to a same cluster, but varying from one cluster to the other ones.

In both the preceding part and the following one of this description, "mould" is generally cited as a singular term, but it will of course be appreciated that any such mould is actually formed by two respective mould halves that must be opened in view of enabling the therein moulded preforms to be removed.

Going now back to the moment in which the preforms are removed from a same mould, these preforms are removed from there at the same time and exhibit, as this has already been stressed, a selectively differentiated temperature.

The second one of the two afore mentioned measures consists in moving the various clusters of the so obtained preforms through an orderly holding and forward conveyance sequence on a cluster-by-cluster basis, as this is described in greater detail below.

With reference to Figure 2, it can be noticed that said clusters A, B, ... N of cavities produce corresponding clusters of preforms A_p, B_p, ...N_p that are shown to be clearly identified by the same reference letters in the cited Figure. Said clusters of preforms are sent in an orderly sequence, eg. first the whole cluster A_p, then the whole cluster B_p, and so on up to the cluster N_p, to a common conditioning station 14 and, from here, according to the same initial sequence, to a common blow moulding station (not shown). In practice, all preform clusters are removed from the mould at the same time and then queued in a holding phase of the cycle, waiting for being conditioned by successive clusters. It is therefore quite a natural fact that, during that holding time, such preforms are subject to cooling down in a differentiated manner according to the length of actual waiting time, so that the longer such a waiting time, the greater said cool-down effect, wherein it should be noticed in this connection that, during such a holding period, the preforms are exposed to the ambient air at ambient temperature.

In view of obtaining the best possible qualitative result with said preforms, the conditioning phase must bring the final temperature of the same preforms to an exactly pre-determined, stable value, regardless of the clusters which each such preform comes from, and since said conditioning phase has constant charactersitics, also the temperature of the preforms undergoing such conditioning should be appreciably constant, regardless of the cluster which they come from or the moment in which their conditioning actually starts. In order to obtain such a result, and considering the above remarks about the normally occurring differentiation in the cool-down of the preforms according to the actual length of

the holding time, it is necessary for the temperatures of the preforms, as they are just removed from the mould, to be differentiated to such an extent that their subsequent normal cooling down, which depends on the length of the holding time corresponding to the particular cluster of preforms, is capable of bringing the final temperature of said preforms, ie. the temperature of said preforms at the beginning of the conditioning phase, exactly to the constant value $T°_c$ that is required for all preforms of all clusters, regardless of the respective position in the conditioning sequence and, therefore, of the length of the respective holding and, as a result, cool-down time.

As a result, the cooling down of the cavities must be aimed at enabling an appropriately differentiated temperature to be reached in the preforms when they are removed from the mould, and such a differentiation depends essentially on both the length of the holding time, during which said natural cool-down takes place, and the final temperature that must coincide with the initial temperature of the conditioning phase.

The present invention is therefore based on the combination of such differentiated cool-down of the mould cavities (and therefore a simultaneous removal of all preforms from the mould) with said preforms being then sent sequentially, on a cluster-by-cluster basis, to the conditioning phase, wherein said differentiated cool-down of the mould cavities is regulated so as to enable each preform to reach the conditioning phase, at the beginning thereof, at the same temperature, keeping the holding time and the resulting natural cool-down of each preform into due account.

To more effectively elucidate this aspect, let us now refer to the diagram illustrated in Figure 6, where the holding time t of each cluster of preforms between their removal from the mould and the beginning of the conditioning phase is indicated in the abscissa, while the temperature T° of the preform bodies upon their removal from the injection mould is indicated in the ordinate. $T°_c$ defines the temperature at which all preform clusters are when enetering or beginning the conditioning phase, said conditioning process being of course equal for all

preform clusters and equal being also the temperature at which said preform clusters enter the blow moulding stage of the process.

The various curves in the above cited diagram shall be intended as representing the temperature pattern in the distinct preform clusters A_p, B_p, .. N_p, wherein for reason of greater simplicity said curves are identified by the same reference letters.

Since it is assumed that the temperature of the first preform cluster A_p is exactly equal to the temperature $T°_c$ at which the same preform are required to be when entering the conditioning station, as this occurs in the traditional technique, then such first cluster A_p does not need to go through any holding or waiting phase; as a result, the related temperature curve is identified by the point A_p located in correspondence of the initial time t_0 and the temperature $T°_c$ at which the preforms are required to enter the blow moulding station.

The subsequent cluster of preforms B_p must on the contrary undergo a holding phase for a time t_b that is equivalent to the time needed by the cluster A_p to go through the conditioning phase; during such holding time, the related preforms undergo a natural cool-down and must therefore be removed from the injection mould at a higher temperature T_b in such a manner that, at the end of the respective holding time t_b, their temperature has steadied down at the same above defined level $T°_c$ required for the preforms to enter the blow moulding station.

The same occurs for the subsequent preform clusters .. N_p, which, owing to their having to undergo holding phases through respectively and progressively longer periods ..t_n , must of course come out of their injection mould at corresponding, progressively increasing temperatures ..T_n, as this can be clearly inferred from the illustration in Figure 6.

In the course of this description, the term preform cluster or cluster of preforms has been used and defined in the assumption that such clusters actually comprise a plurality of preforms, such assumption being on the other hand a logical one for all

those skilled in the art in the light of the basic need for the capacity of every single mould to be utilized to the maximum possible extent, but it will of course be readily appreciated that, albeit in extreme cases, any such cluster may also comprise a single cavity/preform.

The advantage also emerges clearly of having moulds that comprise the greatest possible number of cavities. Such a number, however, is limited technically by such factors as size, cost and ease of handling of the same mould, the interchangeability thereof, the possibility for all preform cavities to be filled simultaneously and evenly, along with a number of other problems that generally tend to set definite limits to the actual size of the mould and the number of the cavities thereof.

With reference to Figure 3, the invention is illustrated schematically in a symbolic, simplified manner. It can be noticed how the extruder 10 is shown to supply via the conduit 11, which may be possibly provided with additional injectors (not shown), the mould 1 that is provided with two distinct clusters of cavities indicated symbolically by two respective segments schematically shown at 12 and 13.

The two clusters of preforms that are removed at the same time from said cavities are lined up in respective holding or waiting sectors 12A and 13A, where they are allowed to cool down naturally, before being transferred sequentially to the conditioning station 14 and, finally, to the blow-moulding station (not shown).

It clearly emerges from this configuration that, since the overall utilization and occupancy time of the injection moulds amounts to approximately four times the blow-moulding time, and that a single phase of injection moulding into two clusters of cavities takes the same time needed for injecting into a mould having a single cluster of cavities, the extruder must therefore work in an intermittent mode of operation, since it must be stopped periodically, after the single mould has been filled, in order to enable the injected molten resin to solidify and cool-down, and also to enable all of the the various actuation and drive members required for the

operation (ie. mould unclamping, handling means, preform ejection/removal, transfer means and the like) to be duly and completely operated.

Under the above cited circumstances, owing to the above mentioned facts, it clearly emerges that the conditioning/blow moulding apparatuses carry out two operating cycles in the same time in which the complete preform injection moulding/cool-down/removal operation goes through a single cycle, while, owing to the differences in the duration of the cycles performed by the various apparatuses, the conditioning and blow moulding ones remain practically still and unused for half of the time. It will be appreciated that such an arrangement may therefore be particularly suitable when bottles must be produced at quite low output rates. In such cases, in fact even a relative inefficiency brought about by the above cited downtime problems can be accepted, since it is generally compensated by a considerable simplification in the overall construction of the equipment and a marked saving effect on general costs.

However, in order to eliminate such an inefficiency due to downtimes, the configuration illustrated in Figure 4 is advantageously proposed. Such a configuration differs from the one illustrated in Figure 3 for the addition of a supplementary mould 16 that is fully similar to the afore described mould 1, including the two clusters of cavities 17 and 18, respectively, as well as for the addition of also two further holding sectors 17a and 18a, respectively, which are again fully similar to the afore described holding sectors 12a and 13a. Thanks to the explanations given above, those skilled in the art will now be capable of readily appreciating that, in this case, the conditioning and blow moulding apparatuses are in fact fully saturated, since after having processed fours successive clusters of preforms produced in a row by the two moulds, they are immediately available for processing four further clusters of preforms produced in the meantime by said two moulds in a subsequent injection-moulding operation.

Such a configuration appears to be particularly advantageous since it combines a marked improvement in productivity with an unaltered simplicity in the construction of the equipment, considering that the output capability thereof can be

practically doubled simply through the addition of said supplementary mould 16, apart of course from the necessary adjustments and set-up requirements in connection with the related control and drive means.

It will also be readily appreciated that the greatest extent to which use can actually be made of the present invention, ie. the multiplication of the number of clusters per each mould while at the same time making use of several moulds, finds its technical and economic limit in the increasing complexity and in the related costs of the quite complex moulds required, in the filling and interchangeability thereof, and in the necessary control and drive means. In principle, however, the invention does not find any conceptual limit.

As far as all the various control and drive means are concerned which are required to clamp and unclamp the moulds, remove the preforms from said moulds, convey and position the preforms of a same cluster in a handling means adapted to simultaneously transfer all such preforms to the conditioning and blow moulding stations, these are in all cases means that, although implementable in the most varied forms for operating according to the most varyied principles, are fully within the capability of all those skilled in the art.

As far as the manners are concerned in which the various zones of a same mould are selectively cooled down in a differentiated way, they do not per sè fall within the actual scope of the present invention, since they can be implemented in a number of ways, the most simple one of which consists in providing, inside the body of the mould, a plurality of conduits, so as to in particular surround each single cavity therewith, wherein a medium is caused to flow through said conduits which is appropriately tempered under thermostatic control in accordance with the actual temperature to which the cavities associated to said conduits must be cooled.

In the course of extensive experiments on prototypes, it has however been found that the external variables, such as for instance the room temperature, the type of resin, the temperature at which such resin is injected in its molten state into

the mould cavities, the thermal inertia of the mould and so on, can bring about a variation in the temperature of the preforms entering the conditioning station.

With reference to Figure 5, such a drawback is therefore eliminated through a detection of the temperature of the preforms, before conditioning, by means of per sè known means 21, 22; according to such a temperature being detected to fall within or to be outside pre-set limits, feedback-operated means are adapted to respond accordingly by generally acting on the cooling means that are associated to the cavities of those moulds from which the preforms have been removed \whose temperature has in such manner been detected to be outside said pre-set limits.

In this manner, as soon as a deviation occurs in the temperature of the preforms from the accepted value, said means automatically intervene to modify the respective temperature accordingly.

The precision of such a deviation range, ie. the extent to which the temperature may be allowed to deviate from the pre-set values, can of course be kept within very strict limits and, in any case, within the tolerance range inside which the temperature of the preforms can vary without any risk of it actually affecting the final moulding result.

In order to improve the responsiveness to a deviation in the temperature of the preforms, as well as to enhance the uniformity in the temperature of the preforms belonging to a same cluster, it is advantageous for said means 21, 22 provided to detect the temperature of the preforms before the conditioning stage to be so arranged as to be able to detect the temperature of those preforms that are thermally most "spaced away" from each other, ie. of that pair of preforms included in the same cluster, which are supposed to exhibit the greatest difference in temperature as compared to any other pair of preforms in the same cluster. It is well within the capabilities of those skilled in the art to identify, even by means of simple measurements, the cavities and, therefore, the pairs of preforms that exhibit such a property.

It will be appreciated that the invention can be implemented also with methods and apparatuses that differ from the above described ones, but complying substantially with the features and characteristics recited in the appended claims.

CLAIMS

1. Single-stage method for the production of preforms of thermoplastic resin, in particular intended for use in a successive blow moulding operation for being converted into bottles or hollow bodies of plastic material, comprising the phases of:

- filling a plurality of multiple-cavity moulds with molten resin for forming said preforms,
- holding and cooling down said molten resin inside said moulds,
- removing the moulded preforms from said moulds,
- subjecting said preforms to a subsequent temperature conditioning stage,
- transferring said preforms to appropriate blow-moulding tools and clamping them therein for their final stretch-blow moulding operation,

wherein each one of said multiple-cavity moulds comprises a plurality of cavities defined in several (n) distinct clusters belonging to the same mould, said cavities being cooled down by means of a forced circulation of cooling medium through appropriate cooling conduits provided in the body of each such mould, characterized in that the cavities belonging to a same cluster are cooled in a distinct and differentiated manner with respect to the cavities belonging to the other clusters of cavities provided in the same mould..

2. Method according to claim 1, characterized in that the preforms of said clusters belonging to a same mould are removed at the same time from their

respective cavities, wherein each such cluster of preforms is subjected individually to said temperature conditioning phase and the subsequent blow moulding phase.

3. Method according to claim 2, characterized in that said clusters of preforms are subjected individually to said temperature conditioning phase in an orderly sequence, so as to cause said clusters of preforms to queue up for reaching said temperature conditioning phase after a differentiated time.(t_b .. t_n)

4. Method according to claim 3, characterized in that to said temperature conditioning phase are sent the clusters of preforms produced by a single and same mould until all clusters of preforms of said mould are finished, and then the orderly sequence goes on with the preforms from distinct clusters of the respective remaining moulds.

5. Method according to any of the preceding claims, characterized in that:

- the cavities in each mould are filled by an extruder adapted to successively send a flow of molten resin to a plurality of injectors associated to respective moulds,
- upon having been so filled up, each such injector injects the therein contained molten resin into the therewith associated mould,
- upon having so filled up all said moulds, said extruder is stopped at least until the preforms are removed from a mould and the latter is made ready to receive a new shot of molten resin.

6. Method according to any of the preceding claims, characterized in that, if the ratio of the time required to complete the blow moulding phase to the time required to complete the overall preform injection-moulding phase is defined as $\underline{K}$, a single blow-moulding station adapted to simultaneously blow-mould a whole cluster of preforms is associated to a single preform moulding mould containing a number of cavity clusters which is equal to the whole numer that is immediately below said number $\underline{K}$.

7. Method according to any of the preceding claims 3 to 6, characterized in that the preforms of successive clusters (A_p, B_p, .. N_p) of the same mould are removed therefrom at differing temperatures (T_o, T_b .. T_n) which are such as to enable all such preforms to reach and stabilize at a substantially same and constant temperature value ($T°_c$) during said differentiated holding periods thereof.

8. Method according to claim 7, characterized in that the temperature of at least a preform of each cluster of each mould is measured at the beginning of the temperature conditioning phase and, should such a temperature be detected as to fall outside pre-defined temperature limits, the cooling down of the cavities relating to said cluster is automatically varied in such a manner as to bring again the temperature of the preforms removed from said cavities within said limits.

9. Method according to claim 8, characterized in that the temperature that is taken as a reference for comparison with said limits is the average temperature of the temperatures of the pair of preforms belonging to a same cluster that exhibit the greatest difference in temperature as compared to any other pair of preforms in that same cluster.

10. Method according to claim 8 or 9, characterized in that the temperature of the preforms is measured immediately before said preforms are transferred to the temperature conditioning phase by means of infrared temperature-detection means.

11. Single-stage apparatus for the production of hollow bodies of plastic material, in particular bottles, comprising a first moulding station equipped with at least a mould (1) provided with a plurality of cavities in which preforms are produced, a blow moulding station in which said preforms are blow moulded into their final shape of finished containers, an intermediate conditioning station (14) in which said preforms are conditioned in their temperature so as to be conferred an optimal temperature distribution pattern in view of the subsequent blow moulding phase, conveyor means adapted to transport in a sequential and orderly manner the preforms from said first moulding station to said final blow moulding station

through said intermediate conditioning station, characterized in that said cavities are adapted to be grouped into a plurality of clusters, each one of which is associated to selectively operable means adapted to cool down their respective cavities to a same temperature that differs from the temperatures associated to the cavities of all other clusters in the mould.

12. Apparatus according to claim 11, characterized in that said means provided to selectively cool down said cavities comprise a plurality of conduits provided in said moulds (1) and associated to means adapted to cause a cooling medium.to flow therethrough at an automatically controlled temperature.

13. Apparatus according to claim 11 or 12, characterized in that it is provided with handling and conveying means adapted to remove said preforms at the same time from the respective moulds, to transfer said preforms sequentially and grouped into distinct clusters to said temperature conditioning and blow moulding stations, as well as means (12a, 13a, 17a, 18a) adapted to keep in their holding state the clusters of preforms as they wait for being transferred to said temperature conditioning station.

14. Apparatus according to any of the preceding claims 11 to 13 or any combination thereof, characterized in that said moulds are in the number of two (1, 16), wherein each one of them is provided with two distinct clusters (12, 13; 17, 18) of cavities for preforms.

15. Apparatus according to any of the claims 11 to 14 or any combination thereof, characterized in that it comprises an extruder (10) adapted to melt the resin that is eventually shot, possibly through appropriate injection means, into the cavities of said moulds, wherein the operation of said extruder is stopped intermittently.

16. Apparatus according to any of the preceding claims 11 to 15, characterized in that it is provided with means (21, 22) adapted to detect the temperature of at

least a preform of each cluster before the latter is transferred to the temperature conditioning station (14).

17. Apparatus according to claim 16, characterized in that it is provided with means adapted to act automatically on said means provided to selectively cool down the cavities whenever.said temperature is detected to fall outside a pre-defined variation range.

18. Apparatus according to claim 16 or 17, characterized in that it is provided with means for detecting the temperature of two different preforms belonging to a same cluster and moulded in respective pre-determined cavities, automatically calculating the average of the so detected temperatures, and. to use such a calculated average temperature value as the reference value to be compared with said pre-defined temperature range.

19. Apparatus according to claim 18, characterized in that the temperature difference between said two different preforms is greater than the temperature difference between any other pair of preforms in the cluster.

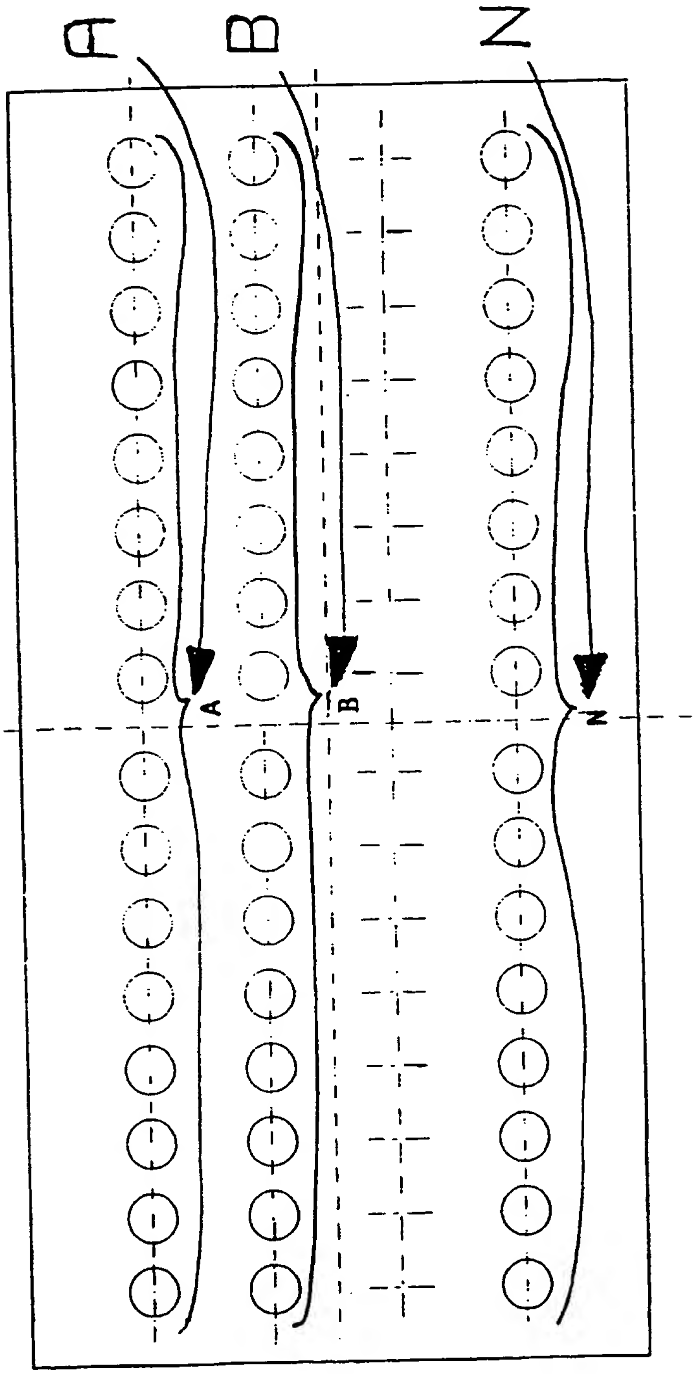

FIG.1

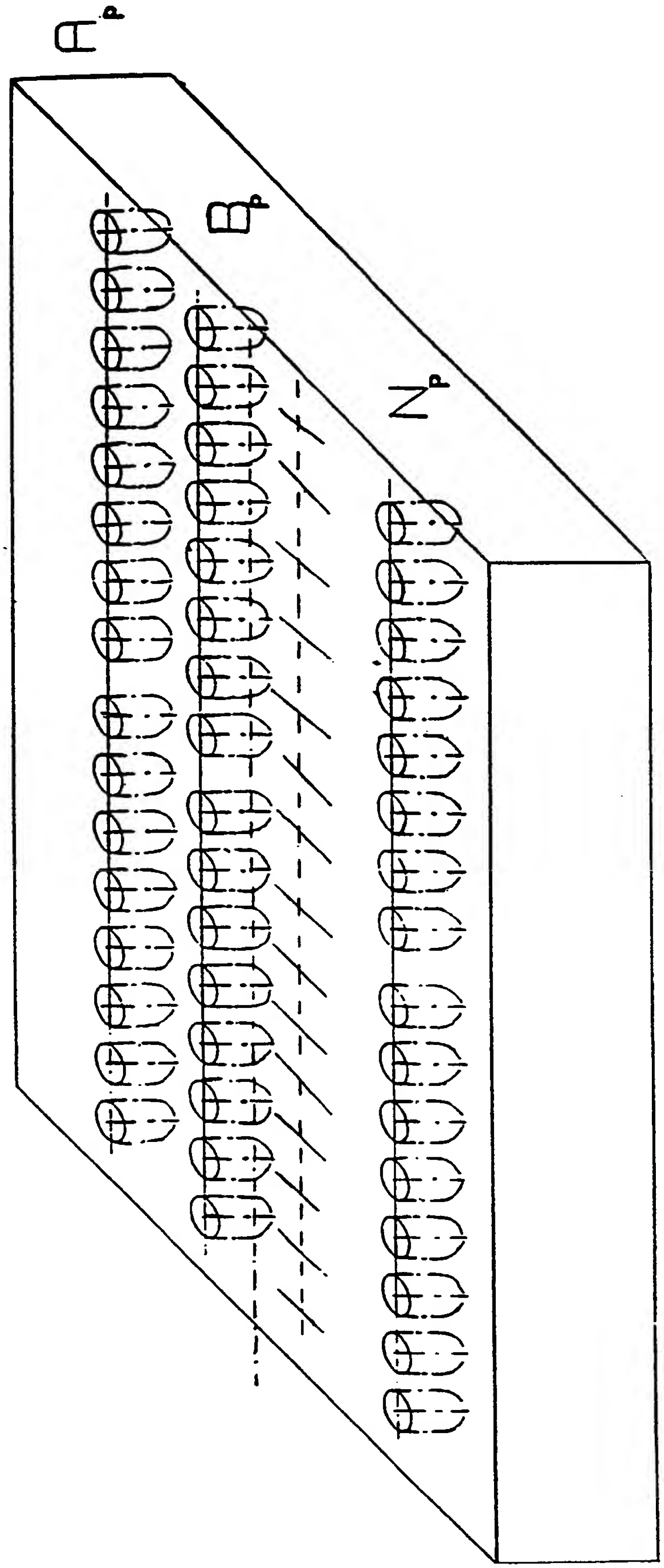

FIG. 2

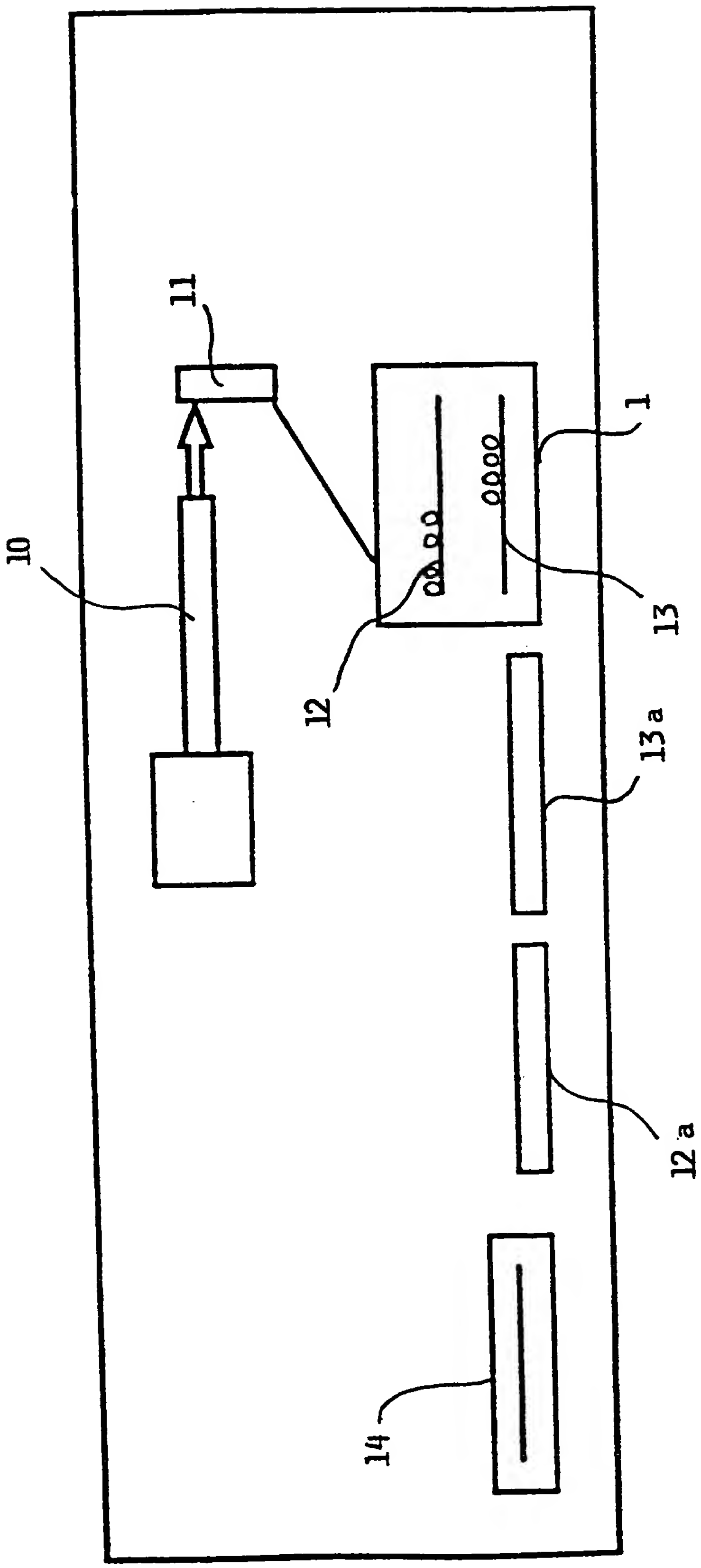

FIG.3

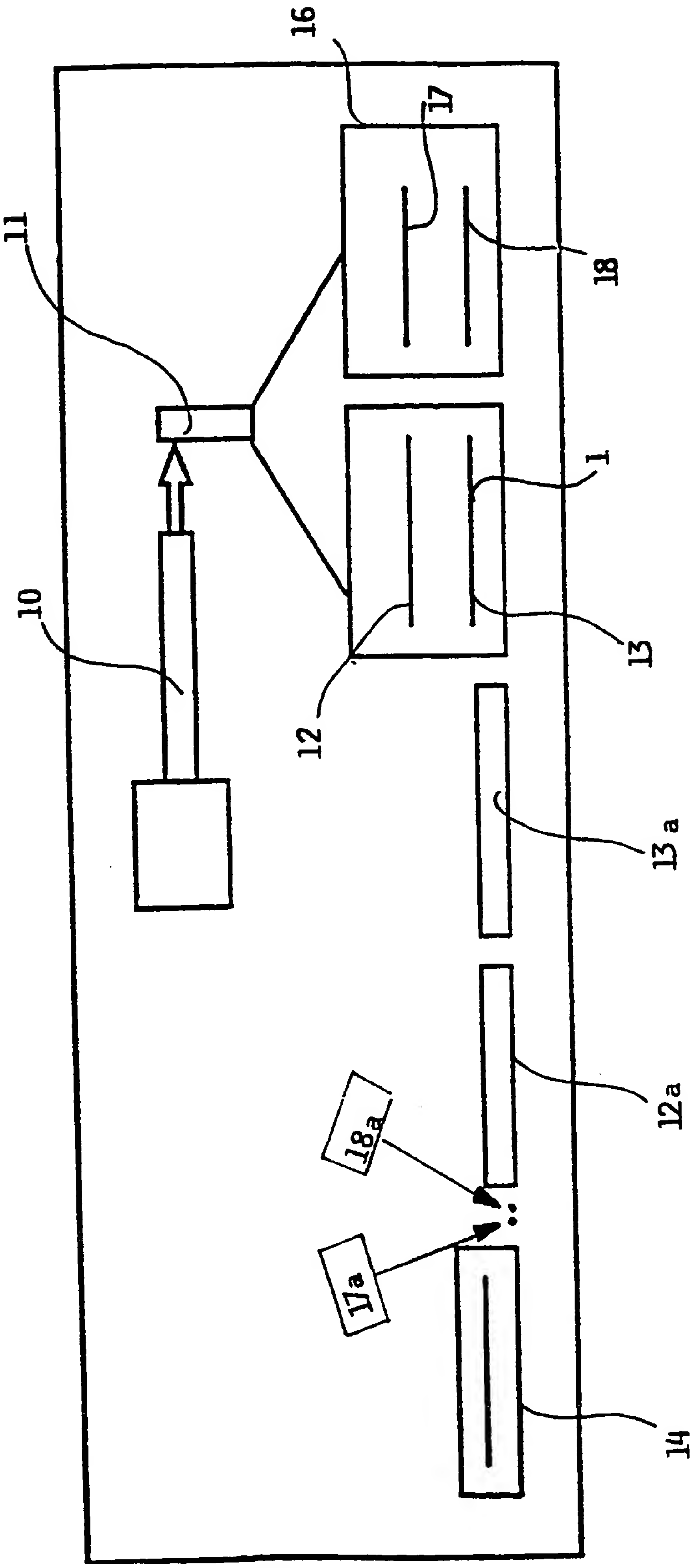

FIG. 4

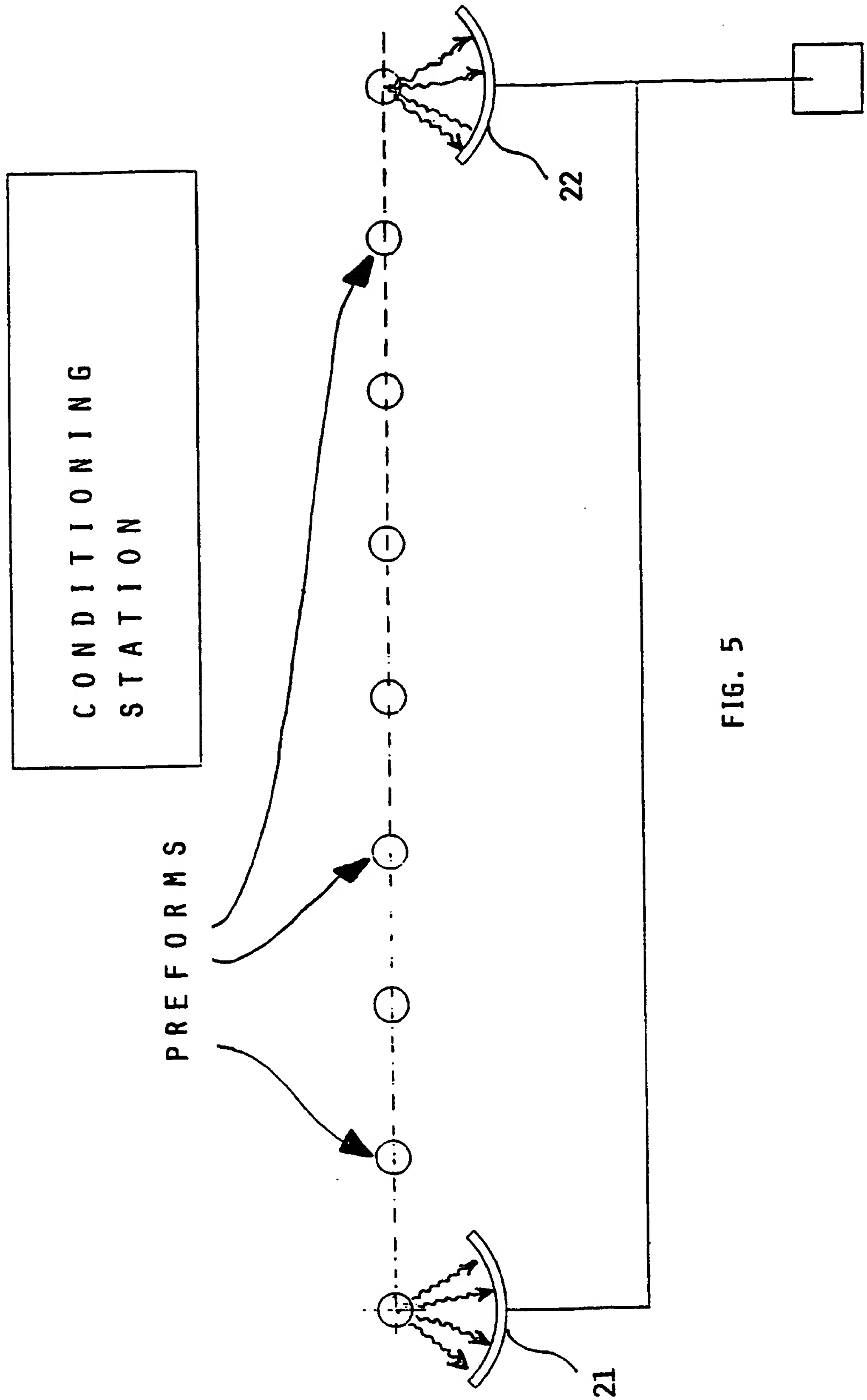

FIG. 5

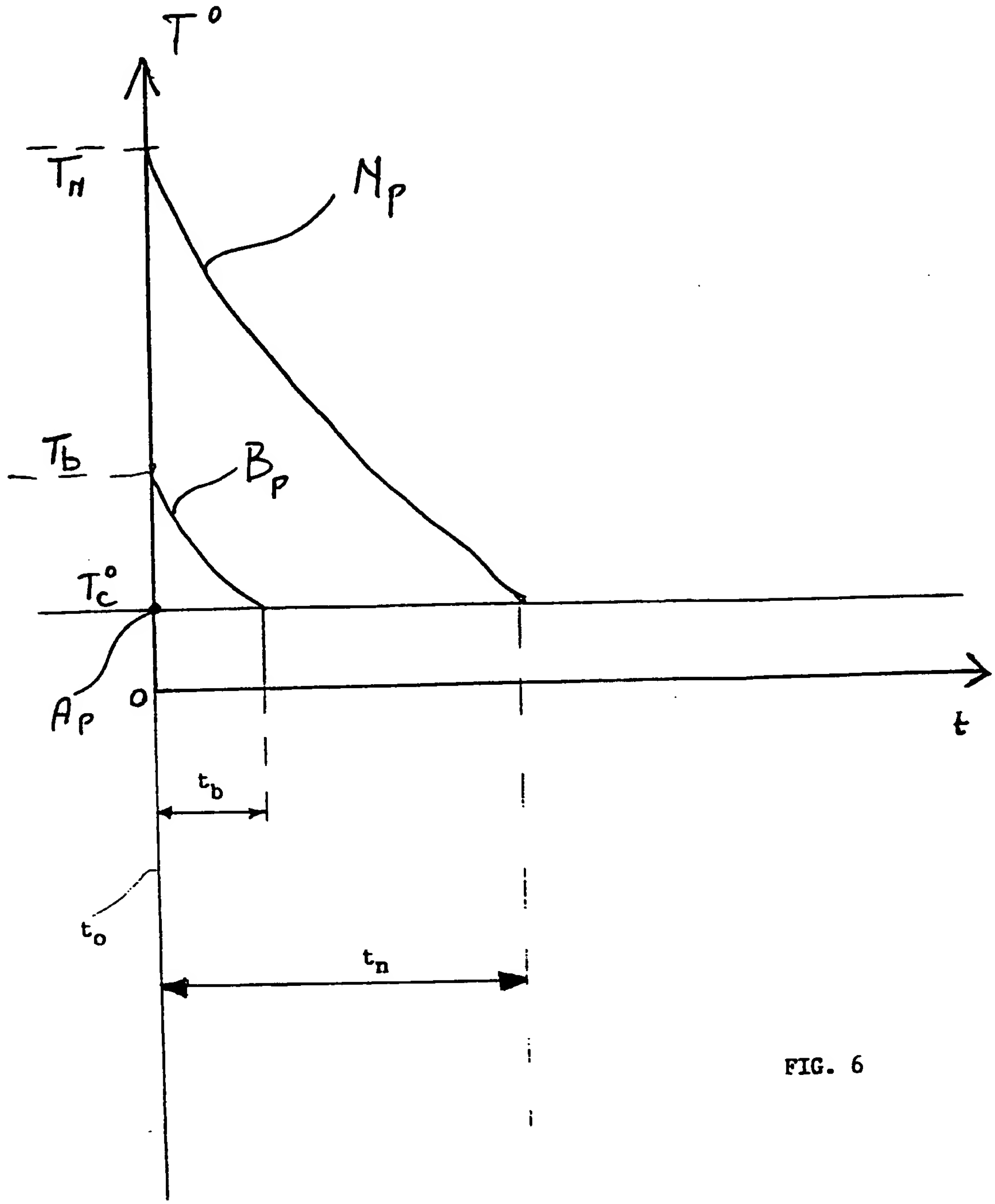

FIG. 6